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# Variability in Exposure to Subspecialty Rotations During Orthopaedic Residency: A Website-based Review of Orthopaedic Residency Programs

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## Abstract

**Introduction:** The variability in exposure to various subspecialty rotations during orthopaedic residency across the United States has not been well studied.

**Methods:** Data regarding program size, resident's sex, department leadership, university-based status of the program, outsourcing of subspecialty rotation, and geographic location were collected from websites of 151 US allopathic orthopaedic residency programs. The relationship of these factors with the time allotted for various clinical rotations was analyzed.

**Results:** The number of residents in a program correlated positively with time allocated for elective rotations ($r = 0.57$, $P = 0.0003$). Residents in programs where the program director was a general orthopaedic surgeon spent more time on general orthopaedic rotations (22 versus 9.9 months, $P = 0.001$). Programs where the program director or chairman was an orthopaedic oncologist spent more time on oncology rotations ([3.8 versus 3 months, $P = 0.01$] and [3.5 versus 2.7 months, $P = 0.01$], respectively). Residents in community programs spent more time on adult reconstruction than university-based programs (6.6 versus 5.5 months, $P = 0.014$). Based on multiple linear regression analysis, time allotted for adult reconstruction ($t = 2.29$, $P = 0.02$) and elective rotations ($t = 2.43$, $P = 0.017$) was positively associated with the number of residents in the program.

**Conclusions:** Substantial variability exists in the time allocated to various clinical rotations during orthopaedic residency. The effect of this variability on clinical competence, trainees' career choices, and quality of patient care needs further study.

The clinical experience during orthopaedic residency may not be uniform across different training programs in the United States. Furthermore, the educational content and format can be affected by

administrative constraints such as duty hour restrictions, patient demographics, and health system constraints of individual training programs. Currently, the American Board of Orthopaedic Surgeons (ABOS) requires 12 months of adult orthopaedics, 12 months of fractures/trauma, 6 months of pediatric orthopaedics, and 6 months of basic and/or clinical specialties (it is unclear what is meant by basic subspecialties in the ABOS guidelines), as well as 4 years of orthopaedic training before an orthopaedic resident can apply for Part 1 certification examination for the ABOS.[1] In surgical specialties such as orthopaedics, the learning curve for commonly performed procedures such as surgical fixation of hip fractures, intramedullary nailing of long bones, and hip arthroplasty is related to exposure to a critical volume of those surgical cases.[2–4]

Based on our review of the peer-reviewed literature, limited information is available on the variability in orthopaedic training among residency programs across the United States.[5] For example, residents in some programs may be exposed to more trauma, whereas others may perform more elective cases in various orthopaedic subspecialties. Studies based on resident case logs reveal substantial discrepancy in the number of surgical cases logged across the residency programs in the country.[5] In addition, a survey study from 2001 noted that that a lower percentage of orthopaedic graduates are comfortable performing spine and oncologic procedures.[6] Thus, it is important for educators to understand the reasons for such variability and discrepancies. Variation in clinical exposure, based on assigned rotations, can potentially affect the distribution of training experiences, including surgical case load encountered by a resident.[7] Understanding the factors that affect clinical exposure and studying the variability of clinical exposure during residency can shed light on how to create a more well-rounded training program.

Thus, the purpose of this study is to analyze the variability and association of factors such as geographic location, university status, program size, sex distribution of residents, subspecialty of program leadership, and presence of outsourced clinical rotations on the amount of time allocated for clinical rotations during residency training. We hypothesized that program demographics can be associated with the amount of time residents spend on different rotations.

## Methods

The data for this study were obtained from publicly available information on the Internet, and thus, IRB approval and informed consent were not required. We reviewed the available online information from the websites of all 151 US orthopaedic residency programs listed by the Electronic Residency Application Service in December 2016 (https://www.nrmp.org/wp-content/uploads/2016/09/Charting-Outcomes-US-Allopathic-Seniors-2016.pdf). To ensure that data have not changed on these websites in the interval period, we used the Wayback Machine (https://archive.org/web/), which is a digital archive of the World Wide Web that downloads all publicly accessible pages.

If available, information on the following variables of interest was retrieved: program location by US census region (ie, Northeast, South, Midwest, and West), residency size including the proportion of female: male residents, total number of full-time clinical faculty and separated by subspecialty, subspecialty of department chairman and residency program director (PD), university-based versus community program, time spent on specific orthopaedic subspecialty rotations, training location for specific subspecialties, and whether the program offered subspecialty fellowships. Forty programs provided data for electives, 107 for foot and ankle, 108 for general orthopaedics, 119 for hand, 113 for adult reconstruction, 99 for oncology, 121 for pediatrics, 81 for research rotation, 118 for spine, 117 for sports, and 118 for trauma. Of note, programs from Puerto Rico and Hawaii were excluded from regional analysis because they did not fall into one of the defined regions and were not large enough to calculate standard deviations as their own group.

The duration of assigned clinical rotations was recorded in months. Any resident clinical rotation listed in weeks was converted to months. If certain rotations spanned over two different years of training and the exact time spent in each year was not specified, the number of months was split evenly between the 2 years (ie, 4 months of pediatric orthopaedics during Post Graduate Year (PG) 2 and PG3 = 2 months PG2, 2 months PG3). Programs that did not specify their rotations were designated as unspecified and excluded from the final analysis. A university-based residency program was defined as one in which the main teaching hospital for post-graduate orthopaedic training was the primary teaching hospital for a medical school. A community program on the other hand was one in which the main teaching hospital was not the primary teaching hospital for a medical school.

Data were organized into range and average number of months spent on each rotation. Using SAS version 9.3, advanced analytics software (SAS Institute Inc), statistical analysis was performed to determine associations between certain continuous and categoric variables. The Student *t*-test was used to compare mean values with normalized data (such as the number

of residents, female residents, and months allocated for specific rotation), and chi-square analysis was used to compare categoric data (such as the presence of a pediatric orthopaedic fellowship in the home program, US census region, and university-based versus community program). The Pearson correlation coefficient was used to determine the strength of a linear relationship among select variables and the duration of pediatric orthopaedic rotation. Multiple linear regression analysis was performed to further study the independent association of variables with the length of various clinical rotations, when two or more variables were found to be significant based on univariate analysis. Differences were considered significant at $P < 0.05$.

## Results

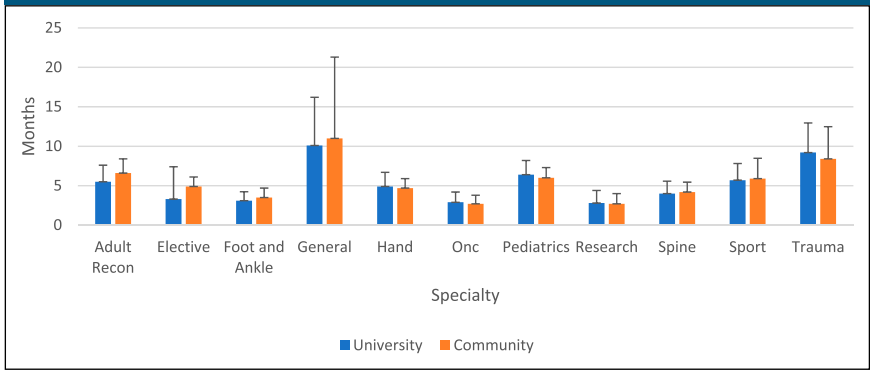
For the 151 orthopaedic residency program websites browsed, the mean time allocated to various clinical rotations by specialty varied from 2.8 months for oncology to 10.3 months in general orthopaedics (Table 1).

**Table 1**

**Average Amount of Time Across all Residencies That Residents Spent on Particular Subspecialty Rotations**

| Specialty | Average Time Spent in Months (Range) |
|---|---|
| Adult reconstruction | 5.7 (0-13) |
| Elective | 3.1 (0-6) |
| Foot and ankle | 3.1 (0-6) |
| General | 10.3 (0-40) |
| Hand | 4.8 (0-12) |
| Oncology | 2.8 (0-6) |
| Pediatrics | 6.3 (4-11.5) |
| Research | 2.8 (0-7.5) |
| Spine | 4.0 (2-10) |
| Sport | 5.8 (0-15) |
| Trauma | 9.0 (2.4-22) |

**Figure 1**




Graph showing the time spent on specific subspecialties compared by university-based versus community programs.

## University-based Versus Community Programs

The average size of a university-based program was 23.6 (10 to 50) residents compared with 14.7 (10 to 30) residents for a community program. There were 116 university-based programs and 35 community-based programs. The time allotted to orthopaedic subspecialty rotation as correlated with university-based versus community programs is summarized in Figure 1. A breakdown of the 2018 Orthopaedic In Training Exam (OITE) questions based on various orthopaedic subspecialties is shown in Figure 2. A direct comparison of OITE topics is difficult because it does not use the topics "adult reconstruction" or "sports." Instead, it divides these topics into knee/hip and shoulder/elbow. To better compare the amount of time spent on rotation to the amount of OITE questions, we can combine the amount of time spent on adult reconstruction with sports to compare to the total amount of questions spent on hip/knee and shoulder/elbow combined. Of the subspecialties, the only significant difference was noted in time allocated to adult reconstruction rotation for residents in university-based versus community programs. University-based programs spent an average of 5.5 months on adult reconstruction compared with 6.6 months in community programs ($P = 0.014$). Furthermore, 47.1% of university-based programs spent greater than 6 months on adult reconstruction compared with 76.9% of community programs ($P = 0.008$).

## Resident Demographics

One hundred forty programs provided information on the total amount of residents they have, and 131 programs provided information on sex distribution of residents in their program. The number of total residents in a program positively correlated with the amount of allotted time for elective rotations ($r = 0.57$, $P = 0.0003$) and negatively

**Figure 2**

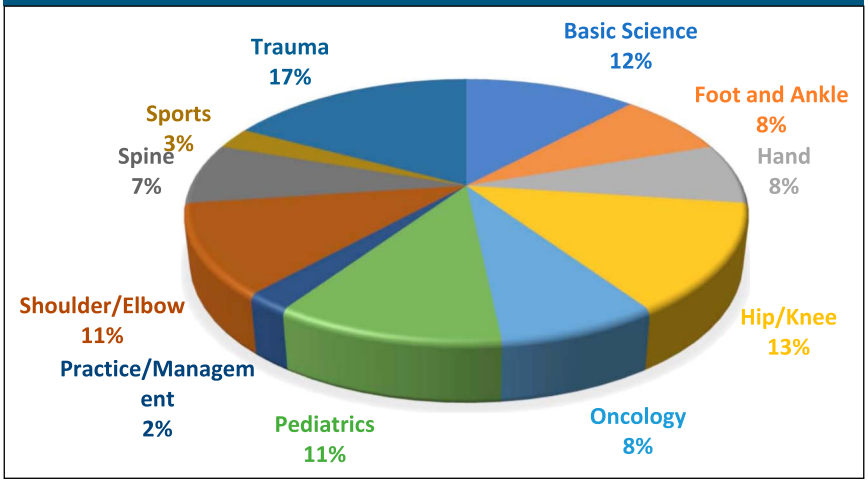



Chart depicting the breakdown in topics found in the 2018 OITE.

**Table 2**

**Relationship of Program Size With the Amount of Time Spent on Subspecialty Rotation With Associated Pearson Correlation**

| Specialty | Pearson Correlation No. of Residents | *P* Value No. of Residents |
|---|---|---|
| Foot and ankle | −**0.25** | **0.01** |
| Elective | **0.57** | **0.0003** |
| General | −0.12 | 0.24 |
| Hand | −0.16 | 0.09 |
| Adult reconstruction | −0.09 | 0.35 |
| Oncology | −0.20 | 0.06 |
| Pediatrics | 0.08 | 0.39 |
| Research | −0.02 | 0.87 |
| Spine | −0.04 | 0.66 |
| Sport | −0.07 | 0.48 |
| Trauma | 0.07 | 0.48 |

Table 2 demonstrates the relationship of the amount of time assigned to each subspecialty rotation and the number of residents in the program.

correlated with time spent on foot and ankle (r = −0.25, *P* = 0.01) (Table 2). The number of female residents in a program positively correlated with the amount of elective rotation time and pediatrics and negatively correlated with time spent on the hand service (Table 3). Multiple linear regression was performed, showing that the total amount of time spent on elective rotations is correlated with the number of total residents even when controlling for the number of female residents.

## Program Leadership

We compared time allocated for various subspecialty rotations with the subspecialty of residency director and department chair. One hundred ten program sites had information about the chair's subspecialty, and 114 programs had information about the residency director's subspecialty.

If the PD was a generalist, residents tended to spend more time on general orthopaedics (22 versus 9.9 months, *P* = 0.001). There was also a slightly increased time spent on orthopaedic oncology if the PD was an orthopaedic oncologist (3.8 versus 3.00 months, *P* = 0.011) and if both the PD and the chairman were orthopaedic oncologists (3.5 versus 2.7 months, *P* = 0.010).

## Outsourced Subspecialties

Programs often send their residents to gain experience in certain subspecialties to off-site locations that may not be directly available at their primary teaching institution. One hundred seven program sites gave information on outsourced subspecialties in foot and ankle, 108 for general, 119 for hand, 113 for adult reconstruction, 99 for oncology, 121 for pediatrics, 118 for spine, 117 for sports, and 118 for trauma. For adult reconstruction, programs that sent their residents to another institution for their arthroplasty experience spent more time on the adult reconstruction rotation than those that stayed at their home program (7.1 versus 5.6 months, *P* = 0.031). Furthermore, residents at programs with a hand fellowship at the home program spent more time on hand rotation than those without a hand fellowship (5 versus 4.2 months, *P* = 0.012).

## Location

Time spent on various subspecialty rotations based on different US geographic regions is summarized in Figure 3. Three subspecialties (foot and ankle, orthopaedic oncology, and trauma) demonstrated statistically significant variability in the time allotted based on geographic regional variation. In foot and ankle, programs in the South and Midwest spent 3.4 and 3.5 months, respectively, compared with 2.8 and 2.9 months, respectively, for

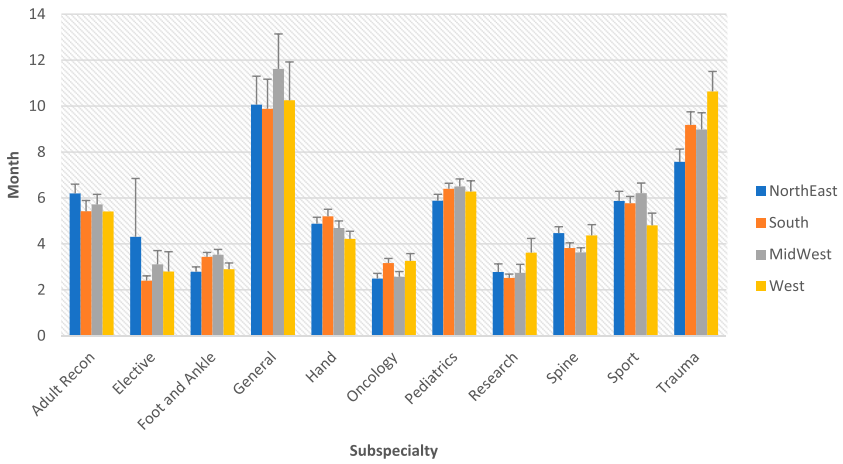
**Table 3**

**Relationship of Sex Distribution With the Amount of Time Spent on Subspecialty Rotation With Associated Pearson Correlation**

| Specialty | Pearson Correlation No. of Females | *P* Value No. of Females |
|---|---|---|
| Foot and ankle | −0.16 | 0.11 |
| Elective | **0.54** | **0.001** |
| General | 0.08 | 0.43 |
| Hand | **−0.22** | **0.03** |
| Adult reconstruction | −0.11 | 0.29 |
| Oncology | −0.17 | 0.12 |
| Pediatrics | **0.21** | **0.03** |
| Research | −0.04 | 0.76 |
| Spine | −0.11 | 0.25 |
| Sport | −0.12 | 0.22 |
| Trauma | −0.05 | 0.64 |

Table 3 demonstrates the relationship of the time spent on specific subspecialty rotation based on the number of female residents in a program.

**Figure 3**




Graph showing mean number of months allocated to specific subspecialty rotations based on the geographic location of the residency program in the United States.

Northeast and West ($P$ = 0.03). In orthopaedic oncology, programs in the South and West spent 3.2 and 3.3 months, respectively, compared with 2.5 in Northeast and Midwest ($P$ = 0.04). Finally, in trauma, programs in the South and West spent 9.4 and 10.6 months, respectively, compared with 7.5 and 8.9 months, respectively, in the Northeast and Midwest ($P$ = 0.03). Based on multiple linear regression analysis, time allotted for adult reconstruction (t = 2.29, $P$ = 0.02) and elective rotations (t = 2.43, $P$ = 0.017) was positively associated with the number of residents in the program.

## Discussion

We studied the variability of time allotted for various clinical rotations across the 151 orthopaedic residency programs in the United States. We found that community programs tended to spend more time on adult reconstruction. Increased numbers of female residents correlated with more time spent on elective and pediatrics and with less time spent on hand rotation. Larger program size correlated with more time spent on elective rotations and that university programs tended to have larger programs. Programs with chairs who were generalists or orthopaedic oncologists tended to have more time allotted to those specialties, respectively. Programs with hand fellowships tended to spend more time on hand rotations. Geographically, programs in the South and Midwest spent more time on foot and ankle, whereas programs in the West and South spent more time on oncology and trauma rotations.

### University-based Versus Community Programs and Outsourcing

Our data demonstrated that residents in community programs on an average spent more than a month longer on adult reconstruction service compared with university-based programs. This phenomenon may reflect the distinctive patient and clinical faculty demographics seen at university-based versus community programs and different perceived needs of training between the two settings. Overall, more arthroplasty procedures are performed at community hospitals compared with university-based centers.[8] This discrepancy may be related to the fact that medical care, including arthroplasty, is more costly at academic centers compared with community centers to account for teaching costs and overall overhead.[9–11] This phenomenon likely contributes to residents in community-based programs spending more time on arthroplasty/reconstruction rotations as noted in

our study. Interestingly, residents who had an off-site location for adult reconstruction training also spent more time doing adult reconstruction. One possible explanation for this finding may be that residents are specifically sent to high-volume arthroplasty centers and thus gain a more focused adult reconstruction experience.

In addition, as seen in the comparison with the 2018 OITE breakdown, the time spent on a clinical rotation is roughly correlated with the number of questions for the given subspecialty. This finding suggests that clinical rotations are fairly well distributed compared with the weightage of questions on the In-Training Examination.

## Sex Distribution

Orthopaedics remains one of the least diverse medical specialties with only about 13.1% of orthopaedic residents being women.[12,13] This phenomenon is particularly interesting, given the fact that medical matriculates are now nearly evenly split between the two sexes.[14] Although there may be multiple reasons for this finding, given the context of our study, we noted a positive correlation between the number of female residents in the program and the amount of time allocated to elective rotations and pediatric orthopaedics. Although it is unclear whether female candidates have a propensity toward programs with more pediatric experience, it is interesting to note that in the 2016 to 2017 academic year, pediatric orthopaedic fellowships had the highest proportion of female matriculates.[15] Although we were unable to establish causality, a survey of orthopaedic residents conducted by Hariri et al[16] noted that a higher percentage of women planned to pursue pediatric orthopaedic fellowship compared with men (24% versus 6%). Perhaps prospective female residents may find programs that focus on pediatrics more appealing and may have more female role models in that field. On the other hand, we noted a negative correlation between the number of female residents in a program and the time allocated to hand rotation. According to Chung et al,[17] significant factors that influence resident selection of hand surgery as a subspecialty are interest in the topic and time exposed to hand rotations. Our study design did not allow us to gain further insight into this topic.

## Program Size

We found that larger programs tended to have more time allocated to elective rotations. This finding could be a reflection of having more resident workforce to distribute the clinical load among residents or an increased resident advocacy as it allows time for residents to explore different academic or service interests. In addition, we found that university-based programs had a higher average number of residents, 23.6 compared with 14.7 across community programs. The Accreditation Council for Graduate Medical Education (ACGME), the governing body of graduate medical education, determines the amount of residents based on program resources—research and educational—and volume.[18] Large academic institutions likely have more ability to accommodate these requirements and thus are allotted more residents. Given the possibility of enhancing resident training, it would be beneficial to understand the effect of elective time on resident education and patient care. A previous study of urology resident education noted that elective time in residency curriculum had a positive effect on the program with increased In-Training Examination scores and resident evaluation of the program without detracting from surgical training, having actually found an increase in graduating senior case log numbers.[19]

## Program Leadership

The residency PD and department chair can influence the educational curriculum and clinical training received by the residents.[20] We noted that having a generalist or orthopaedic oncologist as the PD correlated with more time spent on those clinical rotations. Although it is difficult to say whether the specialty of the department chair/PD directly leads to residents spending more time on those rotations, our results suggest that these leadership positions may influence the educational curriculum of the program. It is interesting to note that in the field of orthopaedic oncology, which is one of the smallest of the orthopaedic subspecialties, simply having an oncology practice as part of a residency program may increase the experience of residents in musculoskeletal oncology.[21]

## Fellowship Offered at Home Program

To have a fellowship, a training program must have a high enough case load, in addition to other academic criteria in that subspecialty.[22] We found that residents in programs that had a hand fellowship in-house were allocated more time on the hand service. Having a fellowship in a particular field likely increases the focus in this subspecialty, which coupled with high case load may allow residents to spend more time in that particular field.

## Geographic Location

Geographic location of the orthopaedic residency may also influence the type of musculoskeletal conditions and diseases seen by the trainees. We found significant correlations between the program location and the

amount of time spent on three subspecialties: foot/ankle, oncology, and trauma.

In the field of foot and ankle, the South and Midwest regions spent more time on foot and ankle rotations. Programs in the West and South spent more months on orthopaedic oncology and on trauma rotations. These differences likely represent variability in orthopaedic pathology by geographical region and differences in regional distribution of orthopaedic subspecialists. One aspect that the regional study does not account for is the local community socioeconomic and makeup of the patient population that the residents encounter and the urban versus suburban versus rural location of the teaching institution. For example, an urban teaching institution that is also a level 1 trauma center will likely receive a high volume of traumatic injuries and will likely be associated with an increased trauma experience for the residents. Another aspect, which may contribute to the discrepancy between the time spent on trauma in the West and Northeast, is the density of trauma programs. According to the Orthopaedic Trauma Association, there are 8 trauma programs in the Northeast compared with 11 in the West region.[23] In addition, of the 10 Musculoskeletal Tumor Society–recognized fellowship programs, 7/10 fellowship programs as of 2017 exist in the South or West.[24] This suggests that time spent on the trauma and oncology services during residency may be higher in and around areas with higher density of such referral centers.

In addition, distribution of medical comorbidities that confound orthopaedic conditions may play a role in the variability of resident clinical exposure. For example, diabetes and obesity have particularly high prevalence in the Midwest and South, according to the Centers for Disease Control.[25,26] These comorbidities are known risk factors for certain foot and ankle disorders[27] and may increase the prevalence of foot and ankle pathology that requires a fellowship-trained foot and ankle specialist. Interestingly, of the 48 foot and ankle fellowships in the United States, 25 are in the South or Midwest.[28] In a study looking at factors influencing fellowship selection by orthopaedic residents, in foot and ankle, practice location was the number one factor and fourth most important factor across all specialties.[29] Furthermore, in a study by Vitale et al[30] studying shoulder procedures, the authors noted as much as a 10-fold difference in the number of total shoulder versus humeral head arthroplasties versus rotator cuff repairs done based on geographic regions. They found significant association between specific shoulder procedures and the population density, but not to the density of orthopaedic subspecialists.

## Study Limitations

Our data were collected from publicly available websites of US orthopaedic residency programs; these data may be inaccurate or out of date. Literal interpretation of the named rotations overlooks the nuances that a particular residency's rotation may contain. For example, a general rotation at a community hospital may include both adult reconstruction and trauma under the same designation. In addition, rotation length, while used as a surrogate of case volume, may not accurately reflect the number of surgical cases that involved active participation by individual residents. Although we did note some trends and associations between time allocated to certain rotations and program demographics, these findings were primarily based on univariate analysis of online data. A more personalized inquiry, including review of resident case logs from each program, would be required to validate our findings.

## Conclusions

The delivery of health care in the United States is evolving rapidly and will likely affect the postgraduate medical education and training. It is important for programs to plan their curricula to optimize resident learning.[31,32] We found some interesting correlations between an orthopaedic residency program's demographic profile and the amount of time allocated to certain clinical rotations during training. Given the paucity of information on this subject, we have provided an introductory foray into some of the demographic factors that may be associated with the length of clinical rotations in orthopaedic residency program across the United States. We hope that our findings can serve as a benchmark to gain further insight into this important topic and can aid educational leaders and other stakeholders of individual training programs to reflect on their educational curriculum.

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